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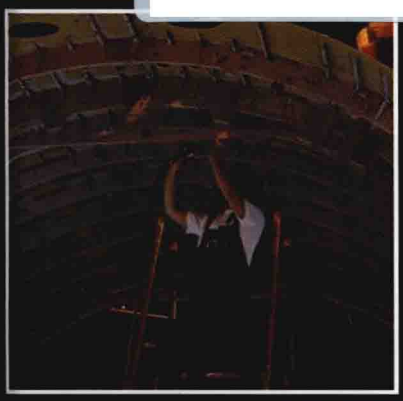

Lightweight Composite Structures in Transport

Design, Manufacturing, Analysis and Performance

Edited by James Njuguna

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Preface

The use of lightweight composite structures has several predictable impacts on the design of transport vehicles, primarily by providing safer, faster, and eventually cheaper transportation in the future. This book therefore explores the recent developments on the use of lightweight composite structures in transport with a special focus on design, manufacturing, analysis, and performance of transport vehicles. It follows that the use of lightweight materials has become more prevalent as transport vehicle manufacturers strive to reduce vehicle weight to improve performance, to lower fuel and oil consumption, and to reduce emissions.

The book is divided in five distinctive parts. Part one covers the lightweighting philosophy and starts with an introduction to lightweight composite materials and their use in transport vehicles in chapter "An introduction to lightweight composite materials and their use in transport structures". This chapter provides an overall introduction into lightweight composite materials and their use in transport structures, mainly thermoplastic, thermosets, elastomers, and core materials. Chapter "Challenges, opportunities, and perspectives on lightweight composite structures: aerospace versus automotive" compares the manufacturing, use, performance, design, analysis, market and supply needs of each industry, and what each industry can learn from the other. The chapter also reviews the challenges and opportunities for the overall composites industry with the use of more composites in automotive applications. Weight as a design parameter is covered in chapter "Opportunities in the design stage of composite components to reduce weight during assembly operations" where the focus is on the lighweighting opportunities at the design stage of composite components to reduce weight during assembly operations. Chapter "The automotive body lightweighting design philosophy" reviews an experience-led philosophy on structural optimization and automobile structural development and yields a series of conclusions. These conclusions combine to form a design philosophy that is very different from that currently employed at both high volume and niche automobile manufacturers.

The second part of the book looks into current developments in manufacturing techniques for lightweight composite structures in the transport industry. In chapter "Cost-effective composites manufacturing processes for automotive applications", an overview is provided on the cost-effective processing techniques employed for manufacturing of automotive parts, primarily using carbon fiber-based thermoset composites. The techniques discussed are resin transfer molding, vacuum-assisted resin infusion process, Quickstep processing with particular emphasis on resin spray technology, pultrusin, filament winding, and compression molding, with emphasis on

recycled carbon fiber-reinforced composites. This is followed by chapter "Hybrid polymer composites for high strain rate applications" on hybrid polymer composites for high strain rate applications and chapter "Thermoset resin sandwich structures" on thermoset resin sandwich structures.

Spread tow carbon reinforcements are a new kind of composite reinforcement, suitable for saving weight. This interesting subject is covered in Part three of the book. The spread tow structure makes it possible to achieve thinner laminates. Straighter fibers with reduced crimp optimize and strengthen the composite. Fewer crimps reduce the amount of excess plastic, thereby minimizing weight. Hence, chapter "Weight reduction by optimized reinforcement structures" looks into some of the existing customer cases from both Formula 1 and aerospace sectors where this new technology has contributed to substantial weight savings.

Part four of the book has four chapters that focus on durability, damage tolerance, and structural integrity of lightweight composite structures in transport. Chapter "Influence of temperature on mechanical properties of short glass fibre-reinforced polyamide 6 and 66 composites for automotive oil pan application" looks into the influence of temperature on mechanical properties of short glass fiber-reinforced Polyamide 6 and 66 composites for automotive oil pan applications. The fatigue behavior of composite materials for high-temperature applications is covered in chapter "The fatigue behavior of composite materials for high-temperature applications" while chapter "Sustainable lightweight vehicle design: a case study in eco-material selection for body-in-white" concentrates on the flammability of composites. A special insight is also provided on composite materials for aerospace propulsion related to air and space transportation in chapter "Composite materials for aerospace propulsion related to air and space transportation".

The readers will also benefit from a set of case studies of lightweight composite design for transport structures. In chapter "Sustainable lightweight vehicle design: a case study in eco-material selection for body-in-white" a case study on ecomaterial selection for body-in-white is provided to demonstrate the sustainable lightweight vehicle design and its motivations. Another case study looks into lightweight design and crash analysis of composites in chapter "Flammability of composites". Next is remanufacturing and whole-life costing of lightweight components, a case study that serves as an inspiration on remanufacturing of composite structures and components. Chapter "Polymer nanocomposite components: a case study on gears" is a case study on gears manufacturing. The final case study covers the manufacture and testing of lightweight tubes for rocketry and centrifuges. Special attention is devoted to resins and fibers utilized in filament winding and damage assessment and prevention of failure, considering the high pressures involved in operation of tubes for rocketry and centrifuges.

This book covering such vital issues and topics definitely should be attractive to the scientific community. It will be a useful tool for scientists, academicians, research scholars, polymer engineers, and industries as it has a unique set of valuable contributions from renowned experts in the transport sector. This book is also supportive for undergraduate and postgraduate students and hopefully an inspiration to many young scientists to devote their efforts in research and development on lightweight designs

and constructions as well as composite materials. The editor is thankful to his post-graduate students, research students, and research fellows who have in one form or another contributed to this book directly or indirectly.

The editor is very thankful to the many contributors who devoted and contributed to this book, more so for their willingness to share their knowledge, expertise, and experience. The editor is also grateful to a great team at Woodhead Publishing and Elsevier for brilliant editorial support throughout this project. Special thanks to Gwen Jones, Kate Hardcastle, Lucy Beg, and Charlotte Cockle who were very helpful in this book project.

J. Njuguna

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